SOUTHWEST FISHERIES CENTER
NATIONAL MARINE FISHERIES SERVICE
P.O. BOX 271
LA JOLLA, CA 92038
SOUTHWEST FISHERIES CENTER
LIBRARY
MAY 30 1989
National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii

MAY 1989

REPORT OF A WORKSHOP ON ESTIMATING MORTALITY OF DOLPHINS IN THE EASTERN TROPICAL PACIFIC U.S. TUNA FISHERY

By

Stephen B. Reilly

ADMINISTRATIVE REPORT LJ-89-12

This Administrative Report is issued as an informal document to ensure prompt dissemination of preliminary results, interim reports and special studies. We recommend that it not be abstracted or cited.

REPORT OF A WORKSHOP ON ESTIMATING MORTALITY OF DOLPHINS IN THE EASTERN TROPICAL PACIFIC U.S. TUNA FISHERY

Stephen B. Reilly

Southwest Fisheries Center
National Marine Fisheries Service
P.O. Box 271
La Jolla, CA 92038

ADMINISTRATIVE REPORT LJ-89-12

TABLE OF CONTENTS

		Page
I.	INTRODUCTION	1
II.	COMMENTS ON COAN et al. Manuscript	2
	Abstract of Manuscript	2
	Summary of Discussion	2
III.	COMMENTS ON EDWARDS et al. MANUSCRIPT	5
	Abstract of Manuscript	5
	Summary of Discussion	6
IV.	COMMENTS ON OLIVER and EDWARDS MANUSCRIPT	10
	Abstract of Manuscript	10
	Summary of Discussion	10
V.	GENERAL COMMENTS ON ALL THREE PAPERS	12
VI.	LITERATURE CITED	14

APPENDICES

APPENDIX 1.	List of Participants	15
APPENDIX 2.	Agenda	16

REPORT OF WORKSHOP ON ESTIMATING MORTALITY OF DOLPHINS IN THE EASTERN TROPICAL PACIFIC U.S. TUNA FISHERY

by

Stephen B. Reilly

I. INTRODUCTION

On January 30 - 31 1989 a workshop was held at the La Jolla Laboratory of the Southwest Fisheries Center to review results of three studies relating to the estimation of annual mortality rates for stocks of dolphins killed during purse seine fishing in the eastern tropical Pacific (ETP) by U.S. vessels. Eighteen people participated in or observed the workshop, representing seven organizations (Appendix 1). The agenda for the workshop is given in Appendix 2.

The National Marine Fisheries Service (NMFS) is responsible for monitoring dolphin mortality on a within-year, nearly real time basis, to determine if and when numerical mortality quotas are reached or exceeded. Under the Marine Mammal Protection Act of 1972 (reauthorized in 1981, 1984 and 1988) the purse seine fishery on dolphins must cease for the remainder of the year when mortality quotas are exceeded. The workshop was convened to review a series of scientific manuscripts which considered refinements in methods currently used to estimate fishery mortality. The papers reviewed were 1) "Comparisons of dolphin mortality rates between day and night sets" (Coan, Wallace and Jackson), 2) "Effects of percent coverage on estimates of cumulative mortality: results from subsampling the 1987 data base" (Edwards, Whalen and Perrin), and 3) "Effects of including dolphins seriously injured and of unknown status in mortality estimates" (Oliver and Edwards).

While the amendments to the MMPA in 1988 mandate that there will be 100% observer coverage, and that sundown sets will be prohibited in general, these topics were considered here as part of long range planning objectives. After 1991 the NMFS must decide upon an optimal level of observer coverage. Starting in 1989, vessel operators may petition the NMFS for an exemption to the prohibition on sundown sets. This exemption is to be based on a finding that the operator's dolphin mortality rate for sundown sets is less than or equal to the industry average for daytime sets. The sundown set paper reviewed here was produced to provide information relevant to this determination.

It was agreed that minor editorial points would be communicated directly to the authors. Such points are not reported here.

II. Comments on, **"Comparisons of dolphin mortality rates between day and night sets for the U.S. eastern tropical Pacific tuna purse seine fishery,"** by Atilio L. Coan, Kenneth E. Wallace and Alan R. Jackson. SWFC Admin. Rept. LJ-88-29.

Coan gave a brief synopsis of the manuscript. The authors provided the following abstract of their study for this report.

> "We reviewed information collected by NMFS and IATTC observers aboard U.S. tuna purse seiners fishing in the eastern tropical Pacific to see if differences occurred in dolphin mortality rates between net sets made during the day and during the night (those starting during the daylight but where backdown occurred in darkness). We investigated possible differences in mortality rates resulting from use of high-intensity flood lights, from placing curfews on night sets, and from including seriously injured animals in the mortality statistics. Results indicated that dolphin mortality rates in night sets were two to seven times greater and are statistically different from mortality rates in sets made during the day. Inclusion of seriously injured animals did not change the differences between day and night mortality rates. Mortality rates were lower by as much as 70% in night sets where high-intensity flood lights were used, as compared to sets where other types of lights were used. Even when high-intensity lights were used, night set mortality rates were still significantly higher than day set mortality rates. The use of curfews could reduce night set mortality by as much as 85%. Further reductions in mortality could be realized if methods can be found to eliminate problems associated with a relatively few high mortality sets."

There were four major topics discussed about this manuscript: stratification of data, problem sets versus sundown sets, effects of light use, and curfews.

In this study the data were not stratified by any factor other than the principal matter of interest here: whether the set was or was not a sundown set. Goodman and Hall both noted the desirability of stratification of the data on other factors prior to analyses testing for the effects of sundown sets on dolphin mortality. Hall elaborated that one implicitly assumes constancy for factors not explicitly considered for stratification. Geographic stratification was considered by the group as the most important, given the spatial heterogeneity of dolphin distribution, and variability in the distribution of fishing effort among seasons and years. The

relatively small sample sizes of sundown sets could be stratified following strata defined by more numerous daytime sets. As discussed further below, the group also discussed possible stratifications relating to problem sets and gear malfunctions.

The manuscript made the point that much of the dolphin mortality in sundown sets resulted from a few extremely high kill sets (mortality of 100 or more). In the discussion, Coan guessed that all of the extremely high kill sets could in fact be attributed to a problem occurring during the set, e.g. equipment malfunction, net collapse or net canopy. A number of participants, including Bernard, Alverson, Salomons and Coan mentioned that if "problem sets" were more prevalent at night, it was likely that many problem sets began as daylight sets, and extended into the night as a result of the problems encountered. Oliver felt that the manuscript did not present information to support these statements, and in fact believes they are inaccurate. There followed a lengthy discussion on definitions for night sets (backdown occurred in darkness), problem set (as above), disaster or higher-kill set (more than 15 killed) and related terminology.

The group also discussed the possible confusion of problem sets that extended to become night sets with night sets that became problem sets due to lack of visibility. Oliver felt that the data as presented did not allow us to draw any conclusions about this, but that information exists in the raw data to clearly differentiate these two types of problem sets. Barlow suggested stratifying on the mean time between setting the net and backdown. DeMaster suggested simply stratifying on the occurrence of problems of any kind (yes or no) for both day and sundown sets prior to estimating mortality rates. In summary, the group felt that this was an important issue, and suggested the authors seriously consider various stratification schemes to clarify the relationships between problem and sundown sets.

One section of the manuscript considered effects of floodlight use in night sets. The basic finding was that using high intensity floodlights significantly reduced dolphin mortality in sundown sets. It was noted that not all light use is standardized, by type of light, location on the vessel or how it is used during a set. Also, prior to July 1986 when lights became mandatory for sets extending into darkness, it may have been the more conscientious skippers who bothered to use lights. This would confound skipper performance with conclusions about the effect of light use for sets made prior to July 1986.

Salomons mentioned that a single light is not always effective at completely illuminating the backdown channel. A discussion

followed on the benefits of adding a second light versus using a single light of higher intensity, with no conclusions reached. The Inter-American Tropical Tuna Commission (IATTC) has been vigorously pursuing the placement of lights on purse seiners since 1982, and will continue to do so. They have not, however, experimented with the larger versus multiple light problem. It was noted that if the NMFS still had a gear program, it would be in a position to address this issue.

The final section of the manuscript examined the effects of curfews (prohibitions on starting sets at various times before sunset) on incidence of dolphin mortality, and concluded that any curfew would reduce nighttime mortality, in some cases by as much as 85%. Hall stressed that eliminating sundown sets by curfew or otherwise will not simply reduce total dolphin mortality on an annual basis by the amounts calculated, because the vessels will replace the prohibited sundown sets with additional daytime sets, because their goal is to fill their vessels with tuna. Ultimately, what will likely occur is that sundown set mortality will be replaced (at least in part) by daytime-rate mortality. Unless the number of fleet-days fished per year increased, this should be a net decrease in total mortality, but it will not be as dramatic as indicated by the manuscript.

Alverson noted that a curfew on fishing later than some specific hour will ultimately have a negative economic impact on the fleet, due to increased trip length to fill a vessel's hold. Other participants suggested that this negative impact be quantified.

III. Comments on, **"Effects of percent coverage on estimates of cumulative mortality: results from subsampling the 1987 data base"** by Elizabeth F. Edwards, Bruce E. Whalen and Christina Perrin. SWFC Admin. Rept. LJ-89-05.

Edwards presented a brief synopsis of the paper. The authors provided the following abstract of their study for this report.

> "During 1987, scientific observers monitoring dolphin mortality accompanied nearly 100% of all U.S. purse-seine vessels involved in the eastern tropical Pacific tuna-dolphin fishery during 1987. The effect on cumulative estimates of dolphin mortality, of lower percent coverages of the tuna-dolphin fleet was investigated by simulating coverages of 25, 33, 50, 75, and 96% during this year of nearly complete coverage. Each percent coverage was simulated 500 and 1000 times, maintaining the temporal structure of the original data set by drawing randomly from each month a percentage, P, of the trips active during that month. Mean estimates of cumulative mortality, the relative bias of these estimates, and their coefficients of variation were derived from each set of replicate samples, for 8 groups of dolphins. These groups were 1) total (all species and stocks combined), 2) northern offshore spotted dolphins, 3) whitebelly spinner dolphins, 4) eastern spinner dolphins, 5) unidentified spinner dolphins, 6) common dolphins, 7) striped dolphins, and 8) other dolphins (dolphins not assigned to groups 2-7). Analytic estimates of cumulative mortality, relative bias and coefficients of variation were derived for each of the percent coverages. Bootstrapped estimates were derived for 33% coverage, basing the bootstrap estimates on the same 500 samples used to derive the analytic estimates at 33% coverage. We found that <u>estimates of cumulative monthly mortality,</u> averaged over 500 or 1000 replicate subsamples at each percent coverage, were very accurate at all 5 coverages (<u>relative bias</u> of the mortality estimates ranged from about -1% to +3%). <u>Coefficients of variation</u> were much more sensitive to data accumulation, decreasing strongly with increased percent coverage and (less strongly) with increased time and increased numbers of dolphins. With 96% coverage, CVs decreased to less than 10% by the end of the year for all groups. With only 25% coverage, however, coefficients of variation ranged from 30-50% for the more abundant groups (total, northern offshore spotted dolphins, whitebelly spinner dolphins, eastern spinner dolphins),

to about 110-150% for the less abundant groups (common dolphins, unidentified spinner dolphins, striped dolphins, and other dolphins). Simulation results were affected only marginally (usually less than +/- 1%) by increasing replication strength from 500 to 1000 samples at each percent coverage, or by bootstrapping estimates rather then calculating analytical estimates."

There was an extensive amount of discussion on this paper, covering at least twelve important issues. Those issues strictly relevant to the study as it was defined by the authors are reported on first, followed by issues raised which are of broader relevance to monitoring ETP dolphin mortality.

Hall commented that the basic conclusions of this paper agree fully with similar simulations performed by Boyer and him when studying the methodology used for estimates for the international fleet (Hall and Boyer 1986).

Hall further commented that besides the traditional formula to compute a ratio estimate, there are 6 or 7 modified formulae that help reduce bias (Hartley-Ross, Pascual, Mint, Beale, etc.), and there is a good review of them in a paper by Rao (1969). Based on the results of simulations done by Hall and Boyer (1986), the IATTC has used Pascual's formula.

Lo explained that the "non-bootstrap" method of subsample selection here was in fact bootstrapping. Because of this, the second stage resampling, called "bootstrapping" in the manuscript, was in fact bootstrapping of bootstrap samples, and therefore redundant and unnecessary for estimating standard errors and evaluating possible biases. She also felt that a sample frequency of about 200 was quite sufficient, that the 500 samples drawn here were more than necessary for estimating the SE of the kill estimates. Hall noted that such large samples are necessary for estimating Monte Carlo confidence intervals which was also a goal of the study. Edwards responded that she would not include the second level resampling in subsequent revisions.

Goodman suggested that relative bias was not a problem here, as shown by Figure 1 of the manuscript. Hall countered that bias may well be a problem for the less-abundant stocks, or if future studies stratify the data and have resulting samples of less than 25%. However, Hall agreed that for the present study, it was appropriate to stress the precision-related results and downplay the concern with relative bias. Barlow suggested the authors test

statistically for the significance of the bias, using standard methods. This should be done before dismissing bias as an issue.

Barlow and Hall felt that Coefficient of Variation (CV) alone may not be adequate, since CVs do not provide information about symmetry of the dispersion of points about the estimate. Barlow suggested reporting 95% confidence limits (preferably bootstrap CLs) in addition to CVs, to give an indication of the shape of the underlying distribution. Others in the group agreed that this or a similar measure was necessary. Hall said that he had found evidence of asymmetry in small sample frequencies in Boyer and his study (Hall and Boyer 1986).

Bernard expressed concern that the combination of lower quotas and higher CVs for the less-abundant stocks would result in less effective kill monitoring for these animals, and increase the likelihood of exceeding a quota without detection. Alverson pointed out that this uncertainty could also have the opposite effect and result in closure of the fishery when in fact the quota had not been reached. There was general agreement that neither of these was a desirable outcome.

Smith and Alverson noted that the stock categories used in this study did not coincide with those used by NOAA Fisheries in actual mortality monitoring. Edwards agreed to provide more specific stock groupings in the next draft.

Hall, Barlow, Goodman, Alverson, Salomons and others discussed the protocol used to select trips for subsampling in this study, noting that while it maintained the temporal structure of the data, it inappropriately allowed the possibility of vessels being sampled (carrying observers) on consecutive trips. Salomons has been conducting a series of simulations subsampling the 1987 data without temporal ordering. He has completed 117 of 200 planned runs. Results so far indicate that his sample mortality estimates have been within 25% of the actual values, for all species and stocks combined. In her revision, Edwards will provide estimates from simulations at 50% coverage, using a selection algorithm that prevents consecutive sampling of trips from individual vessels.

The above discussions about measures of precision led to a discussion about the use of point estimates in management decisions. In particular, the panel discussed the situation in which a determination is made of when a specific mortality quota was reached, which would trigger the closure of a fishery. Goodman's opinion was that, in general, resource managers tend to make decisions based on point estimates, but then if a controversy arises, both sides in the controversy will dispute the decision

based on the uncertainty of the information. There was a general consensus that it was highly undesirable to use only point estimates for decision making, when additional, important information is available from measures of precision. Smith stated that he and other resource managers would be very happy to use CVs or similar statistics in such decisions, if there existed a straightforward system to do so.

Bernard commented that this study contained an implicit assumption that there was no "observer effect", that is a reduced rate of dolphin mortality in the presence of an observer. She referred to previous studies by Whalen and Smith (1985) and Croom (1980) which give strong, albeit indirect, indications that such an effect may exist. This stimulated a lively discussion on the observer effect. The basic points made in this discussion were that: 1) the papers referred to above were very suggestive, but alone can not be taken as "proof" that such an effect occurs systematically, 2) by definition, we can not measure directly what occurs in the absence of an observer, and this lack of direct evidence obviates conclusions either for or against the existence of the "observer effect."

The present NMFS and international observer programs are run with the default assumption that mortality occurs on unobserved trips at the same rates as on observed trips, other factors being equal. This assumption has been questioned, but the managers (of both the US and international observer programs) face a dilemma. If they no longer assume the absence of an observer effect, then the effect must be quantified in order to be applied to existing data. No information exists to test directly for or quantify this effect. It is unlikely that this situation will be resolved given present information.

For the present manuscript, Edwards agreed to state explicitly in the text that this study assumes the absence of an observer effect.

DeMaster commented that the results of this study indicated the usefulness of the kill-per-day statistic for intra-season mortality monitoring. Others agreed.

In discussing the overall results of this manuscript, there were at least five additional topics covered. Goodman summarized what he saw as the relevant aspects of these points:

1) We need to establish quantitative criteria to decide how many years of 100% coverage are required. Smith felt that this was an essential issue, looking toward 1992 when the Service must decide upon a level of coverage for the long term.

2) The NMFS should consider establishing a "quality control" system to monitor actual precision of our mortality estimates, and perhaps spatial coverage, on a within-year basis. This would permit us to know the true level of certainty of our estimates, should it appear that a quota would be exceeded, rather than assuming a level of precision based on averaged, past data. Goodman noted that there are many examples of such systems from industrial quality control, and in environmental monitoring. He suggested an appropriate reference to this field (Vardeman and David 1984).

3) The spatial distribution of coverage should be carefully considered. If necessary, mortality monitoring research (such as the present manuscript) should be based on spatially stratified data.

4) The feasibility of intra-season adjustment of the level of observer coverage should be reconsidered. This could interact with the "quality control" type of intra-season monitoring.

5) The scheme for pro-rating unidentified dolphins to identified stocks should be reconsidered. Because of spatial heterogeneity in the distributions of the stocks, and temporal changes in where the fleet operates, it is possible that data from one area could be incorrectly prorated based on data collected earlier in another area.

A case of special concern is the eastern spinner stock. Depending on the data used as the basis for pro-ration of unidentified spinners, the NMFS could either count too few or too many of them as from the eastern stock. It is possible that the quota for this stock would be exceeded in reality without detection, due to too few unidentified spinners being prorated to the eastern stock. Alternatively, if too many unidentified were prorated to the eastern stock, it is possible that the fleet would be prohibited from dolphin fishing, when in fact the quota had not been exceeded. Both are highly undesirable results.

IV. Discussion of, **"Effects of including dolphins seriously injured and of unknown status in mortality estimates,"** by Charles W. Oliver and Elizabeth F. Edwards. SWFC Admin. Rept. LJ-89-04.

Oliver opened the discussion on this paper by giving a brief synopsis of the study. The authors provided the following abstract for this report.

> "Observers have accompanied a sample of U.S. tuna purse seine vessels fishing in the eastern tropical Pacific since the late 1960s. The number, sex, age-class and species of dolphins killed during the fishing operations have been recorded and subsequently used to estimate annual mortality. Observers also tally additional categories describing an animal's condition at the time of release from the net. In this study we describe the frequency of occurrence of animals categorized as either seriously injured, status unknown, or both for the period 1975 - 1988. We investigated the effects on annual mortality estimates of including some or all of the animals recorded as seriously injured or of unknown status. Including all animals recorded as seriously injured would have increased annual mortality estimates by an average of 4.2% for the entire period 1975 - 1988, but by just 1.8% for years since 1981. Including status unknown animals would have increased annual mortality rate estimates by an additional 2.7% a year, on average, for 1975 - 1988, and 1.6% since 1981. The occurrence and magnitude of these additional tallies varied between species and years."

Barlow and others suggested that the authors carry out statistical tests of some of the factors considered in this analysis. Specifically, an analysis of variance would be quite informative. Tests of significance could be applied to determine, for example, if the apparent decline in rates of seriously injured dolphins recorded in recent years is in fact a significant decline from previous years.

Hall suggested examining the rates of serious injury and related statistics by time of day, to see if (for example) there were more or fewer injuries during sundown sets. Bratten suggested that the effects of using high intensity lights also be investigated. If higher injury and/or undetermined status rates were reported when lights were used this would indicate under reporting in other sundown sets when lights were not used.

Goodman suggested examining serious injury rates in relation to observed kill rates, in particular in relation to high kill or "problem" sets. One might expect higher injury rates to accompany higher kill rates. If this was not observed, it might indicate that the observers attention was concentrated on just documenting the number dead, and he wasn't able to monitor closely the various cues that indicate serious injury.

Bernard commented that the apparent decline in injury rates in recent years could be due to many factors, including differences in the way in which observers record information. If their instructions, or their motivation to be attentive to the incidence of injury had changed, this could result in the apparent declines.

Smith, DeMaster and Bernard expressed concerns that because the percent increases in kill estimates from inclusion of seriously injured and status undermined were low, some might conclude that these factors were not important. DeMaster pointed out that as a quota was approached, the so-called small increases from including these animals in the kill estimates would increase in importance.

There was consensus on the less than satisfactory definition of serious injury, and our subsequent inability to be more definitive about how many of these injuries are likely to lead to death. Hall provided the following suggestion, "In general terms, I believe we should seek advice from experts on dolphin pathology-traumatology about what are the probabilities of recovery from different types of injuries, etc. My limited knowledge of humans and domestic animals tells me that "bleeding profusely" may not result in any serious damage, but on the other hand, internal bleeding may be unnoticeable and a lot more serious. I'm not trying to make a case that bleeding should not be considered, but that we need expert advice to improve definitions, and make better decisions about prorations, etc." Other, related suggestions included the polling of current and ex-observers to determine the frequency of occurrence of various types of injuries not detailed in the present data forms.

There were a number of comments about possible schemes to adjust the kill estimate by including some of the injured or undetermined status dolphins, including using a 5 yr moving average of these statistics, rather than simply estimates from the current year. In general, there was no consensus or conclusion reached about how to deal with animals recorded as injured or undetermined. The exception was that Smith noted a recent decision to change the way NMFS tallies dead dolphins (i.e. animals observed to pass through the power block will in the future be counted as dead).

This is consistent with the IATTC convention for such animals. Most participants seemed to feel that a better definition of the consequences of specific types of injuries was required before conclusions could be reached, following Hall's comment above.

V. General comments on all three papers.

A number of participants requested more detail and information on why the particular methods used were chosen, for all three manuscripts. The authors agreed to provide this in subsequent drafts.

It was suggested that all three studies consider stratification based on (at least) spatial information. Hall said that he had been obtaining CVs on the order of 10% for the international fleet for the last few years, using stratification.

Some participants said that they would like to see detailed documentation of the computer programs used for simulations and analyses, and the logical path taken to arrive at the particular analyses reported. This would facilitate partial or total audits of the mortality estimation procedures, should it ever be required. This suggestion was discussed at some length. Barlow and Reilly commented that, in accordance with standard scientific methodology, it was appropriate to document fully methods and rationale employed in reaching the final, reported results, but that documenting all of the blind alleys and unfruitful analytic attempts that are part of most scientific studies was of dubious value, and would be very costly in time and effort.

Smith again commented that, as discussed under the Edwards et al. manuscript above, the Southwest Region of the NMFS is looking for specific guidance as to the appropriate level of coverage it should implement in 1992 (the current MMPA mandates 100% coverage through 1991).

Results discussed at this workshop indicate that coverage of 25% to 50% is adequate for monitoring total and northern offshore spotted dolphin mortality. Higher levels of coverage may be necessary for those stocks where mortality levels are relatively lower. A coverage rate of 50% was adequate for whitebelly spinner and eastern spinner dolphins. Bias, or systematic under or over estimation of mortality, may also be important for monitoring stocks where mortality levels are relatively low. Modifications to the three papers reviewed here should address these issues, as much as possible. It may be necessary to focus on the monitoring of less-abundant stocks in a separate analysis.

Alverson and others expressed interest in seeing documentation of the economic cost to the tuna fleet resulting from error levels anticipated from varying levels of observer coverage. Barlow commented that this would be very difficult to compute, since we can not easily predict what the fleet will do in future years. Alverson suggested that one could approximate what the fleet might do, and go from there.

DeMaster reminded the group that decisions made about coverage levels for the U.S. fleet have direct implications for the foreign fleet as well. Under current U.S. tuna import regulations, the foreign fleet must have observer programs that are comparable to the US program, and so will be expected to field observers at the same rate.

Bernard noted that the MMPA mandates reducing the "take" of dolphins in the fishery, not just the kill, to levels approaching zero. Taking dolphins includes capturing them, and this larger issue had not been dealt with in this workshop. Bernard hoped that this larger issue would in fact be dealt with explicitly in the near future.

The intent of this workshop was to review the three papers discussed here. The purpose of this report is to document that review process. Some important, larger issues in the monitoring of ETP dolphin mortality, and the reduction of that mortality to levels approaching zero were discussed in part during the workshop. These larger issues were not dealt with in a comprehensive manner here. This larger reckoning is necessary. DeMaster plans to work with the Southwest Regional staff to prepare such a document in the near future.

LITERATURE CITED

Croom, M. 1980. The tuna-porpoise problem: management aspects of a fishery. M.S. Thesis, Oregon State University, 41pp.

Hall, M. and S. Boyer, 1986. Incidental mortality of dolphins in the eastern tropical Pacific tuna fishery: description of a new method and estimation of 1984 mortality. Rep. int Whal. Commn 36: 375 - 381.

Rao, J.N.K. 1969. Ratio and regression estimates. pp. 213-234, in: Johnson, N.C. and H. Smith, Jr. (Eds.), New Developments in Survey Sampling. Wiley Interscience, N.Y., 756 pp.

Whalen, B.E. and T.D. Smith, 1985. Observer effect on incidental dolphin mortality in the eastern tropical Pacific tuna fishery. Fishery Bulletin 83(4): 521-530.

Vardeman, S. and H.T. David, 1984. Statistics for quality and productivity. Amer. Statistician 38: 235-243.

APPENDIX 1

LIST OF PARTICIPANTS

DOLPHIN MORTALITY WORKSHOP
JANUARY 30 - 31, 1989
SOUTHWEST FISHERIES CENTER

Alverson, Frank	American Tunaboat Association
Barlow, Jay	Southwest Fisheries Center (SWFC), NOAA Fisheries
Bernard, Hannah	Greenpeace
Bratten, Dave	Inter-American Tropical Tuna Commission (IATTC)
Coan, Al	SWFC
DeMaster, Douglas	SWFC
Edwards, Elizabeth	SWFC
Goodman, Dan	Marine Mammal Commission
Hall, Martin	IATTC
Jackson, Al	SWFC
Joseph, James	IATTC
Lo, Nancy	SWFC
Oliver, Charles	SWFC
Perrin, Christine	SWFC
Reilly, Steve (convener)	SWFC
Salomons, Robert	Living Marine Resources - Fisheries Research, Inc.
Smith, Gary	Southwest Region, NOAA Fisheries
Swartz, Steve	Center for Environmental Education

APPENDIX 2

AGENDA

DOLPHIN MORTALITY WORKSHOP
JANUARY 30 - 31, 1989
SOUTHWEST FISHERIES CENTER

January 30

1:00 pm	Begin. Introductions. Adoption of agenda.
1:30	Discussion of Coan et al. manuscript.
3:00	Break.
3:20	Resume discussion of Coan et al. (ms).
4:00	Begin discussion of Edwards manuscript.
5:00 pm	End for the day.

January 31

8:30 am	Resume discussion of Edwards (ms).
10:15	End discussion of Edwards (ms). Break.
10:30	Begin discussion of Oliver and Edwards manuscript.
12:00	Lunch.
1:15 pm	Resume discussion of Oliver and Edwards (ms) if necessary.
4:00 pm	Closing discussions.
4:30 pm	End of workshop.